

CLAIMS

1. A semiconductor device which comprises:
 - an N-type semiconductor substrate including arsenic as an impurity and having a ground surface formed on one surface thereof, said ground surface having concavo-convex irregularities;
 - a first electrode formed on another surface other than said one surface of said N-type semiconductor substrate;
 - a second electrode formed on said ground surface and ohmically-contacted with said N-type semiconductor substrate through said ground surface; and
 - a semiconductor element formed in said N-type semiconductor substrate and in which an electric current flows between said first electrode and said second electrode during an ON-state thereof.
2. A semiconductor device according to claim 1, wherein said N-type semiconductor substrate is a silicon substrate.
3. A semiconductor device according to claim 2, wherein a concentration of said arsenic is in a range between 7×10^{18} - $1 \times 10^{21} \text{ cm}^{-3}$.
4. A semiconductor device according to claim 3, wherein a resistivity of said N-type semiconductor substrate is less than $0.008 \Omega \cdot \text{cm}$.

5. A semiconductor device according to claim 1, wherein
a thickness from a surface of said first electrode to a
surface of said ground surface is 200-450 μ m.

5 6. A semiconductor device according to claim 1, wherein
said semiconductor element is a MOSFET, said first electrode
is a source electrode of said MOSFET, and said second elec-
trode is a drain electrode of said MOSFET.

10 7. A method of manufacturing a semiconductor device,
which comprises the steps of:
 (a) preparing an N-type semiconductor substrate
including arsenic as an impurity and having a predetermined
thickness;

15 (b) forming a semiconductor element in said N-type
semiconductor substrate, said semiconductor element flowing
an electric current in a direction of said thickness of said
N-type semiconductor substrate, said step (b) including a
step of forming a first electrode on one surface of said
20 N-type semiconductor substrate;

25 (c) after said step (b), grinding another surface
other than said one surface of said N-type semiconductor
substrate to reduce said thickness and to form a ground
surface on said another surface of said N-type semiconductor
substrate which has concavo-convex irregularities; and

(d) after said step (c), forming a second electrode on said ground surface so that said second electrode is ohmically-contacted with said N-type semiconductor substrate.

5 8. A method of manufacturing a semiconductor device according to claim 7, comprising the further step of using said semiconductor device in a motor vehicle.

10 9. A method of manufacturing a semiconductor device according to claim 7, wherein said step (a) is a step of preparing a silicon substrate.

15 10. A method of manufacturing a semiconductor device according to claim 9, wherein said step (a) is a step of preparing an N-type semiconductor substrate including an arsenic concentration of which is in a range between 7×10^{18} - $1 \times 10^{21} \text{ cm}^{-3}$.

20 11. A method of manufacturing a semiconductor device according to claim 10, wherein said step (a) is a step of preparing an N-type semiconductor substrate resistivity of which is less than $0.008 \Omega \cdot \text{cm}$.

25 12. A method of manufacturing a semiconductor device according to claim 7, wherein said step (c) is a step of grinding said another surface of said N-type semiconductor

substrate until a thickness from a surface of said first electrode to said ground surface is 200-450 μ m.

13. A method of manufacturing a semiconductor device according to claim 7, wherein said step (b) is a step of forming a MOSFET in said N-type semiconductor, said first electrode being a source electrode of said MOSFET, and said step (d) is a step of forming a second electrode which is a drain electrode of said MOSFET.

10

14. A method of manufacturing a semiconductor device according to claim 7, wherein said step (c) is a step of grinding said another surface of said N-type semiconductor substrate by a surface grinding process.

15

15. A method of manufacturing a semiconductor device according to claim 14, wherein said step (c) is a step of surface grinding said another surface of said N-type semiconductor substrate by using a grindstone granularity of which 20 is between No. 300-No. 500.

20

16. A method of manufacturing a semiconductor device, which comprises the steps of:

25

(a) preparing an N-type semiconductor substrate;
(b) forming a semiconductor element in said N-type semiconductor substrate, said semiconductor element flowing an electric current in a direction of a thickness of said

N-type semiconductor substrate, said step (b) including a step of forming a first electrode on one surface of said N-type semiconductor substrate;

5 (c) after said step (b), grinding another surface other than said one surface of said N-type semiconductor substrate to reduce said thickness and to form a ground surface on said another surface of said N-type semiconductor substrate which has concavo-convex irregularities, a thickness from a surface of said first electrode to said ground
10 surface being 200-450 μ m; and

(d) after said step (c), forming a second electrode on said ground surface so that said second electrode is ohmically-contacting with said N-type semiconductor substrate.

15

17. A method of manufacturing a semiconductor device according to claim 16, wherein said semiconductor device is a device for a motor vehicle.

20

18. A method of manufacturing a semiconductor device according to claim 16, wherein said step (a) is a step of preparing a silicon substrate.

25

19. A method of manufacturing a semiconductor device according to claim 18, wherein said step (a) is a step of preparing an N-type silicon substrate including an arsenic

concentration of which is in a range between 7×10^{18} - $1 \times 10^{21} \text{ cm}^{-3}$.

20. A method of manufacturing a semiconductor device
5 according to claim 19, wherein said step (a) is a step of preparing said N-type silicon substrate to have a resistivity of which is less than $0.008 \Omega \cdot \text{cm}$.

10 21. A method of manufacturing a semiconductor devie according to claim 16, wherein said step (c) is a step of grinding said another surface of said N-type semiconductor substrate by a surface grinding process.

15 22. A method of manufacturing a semiconductor device according to claim 21, wherein said step (c) is a step of surface grinding said another surface of said N-type semiconductor substrate by using a grindstone granularity of which is between No. 300 - No. 500.

20 23. A semiconductor device for a motor vehicle which is demanded with a withstanding voltage of 50-60V, which comprises:
25 an N-type semiconductor substrate including arsenic as an impurity and having a ground surface formed on one surface thereof, said ground surface having concavo-convex irregularities;

a first electrode formed on another surface other than said one surface of said N-type semiconductor substrate;

5 a second electrode formed on said ground surface and ohmically-contacted with said N-type semiconductor substrate through said ground surface; and

a semiconductor element formed in said N-type semiconductor substrate and in which an electric current flows between said first electrode and said second electrode during an ON-state thereof.

10

15

20

25